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PECULIARITIES OF ACOUSTIC IMPACT AND PHYSICAL EXERCISE ON THE STATE OF ORGANISM DEPENDING ON SEX AND TEMPERAMENT OF PERSONS UNDER TEST

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ABSTRACT

It is shown the possibility of using hardware complex “Bioscope” to assess the functional state of the human organism in norm and under various external influences. It is revealed the essential difference in the spectral distribution of the “Bioscope signals depending on the dominant type of human temperament.

Key words: *“Bioscope”, state of the human body, external physical impact*

INTRODUCTION

Currently, technological progress has led to a drastic change of life pace of population and growth of external factors which causes stress and formation of various pathological changes in the human body. Therefore, it is urgent to develop new effective methods of objective monitoring of the human state.

In this regard, of particular interest is developed in Armenia hardware complex “Bioscope” [1]. The device does not respond on inanimate objects having ambient temperature however its readings become characteristic oscillation if a biological object is placed at some distance.

Structurally, the “Bioscope” consists of a source of light radiation (laser), a photodetector and sensor wichis a glass plate coated with an opaque material. The radiation source, a glass plate and a light detector are completely isolated from the outside by covering with an opaque material and metal. It records the intensity of light scattered from a glass plate and opaque material.

Various biological objects affect the readings of “Bioscope”" in different degrees, besides the signals of the device are changed when the physiological state of the organisms under investigation is altered [2, 5]. Studies have shown that, in contrast to conventional devices, signals of “Bioscope” reflect the physiological state of a holistic (integrative) state of the organisms [3-5].

Taking into account the possible prospect of using “Bioscope” for daily monitoring of the human state it is important as a first step to study for obtaining the standard values of the “Bioscope” signals for different groups of people.

MATERIALS AND METHODS

The study was conducted with the participation of students (10 male and 10 female) of 20-22 years. Using the hardware complex “Bioscope” it has been conducted a 3-minute registration of the students’ physiological state by placing their left hand palm at a distance of 1 cm from the sensor of “Bioscope”. Registration was carried out in the norm (*Fig. 1*), immediately after the acoustic influence and immediately after physical exercise.

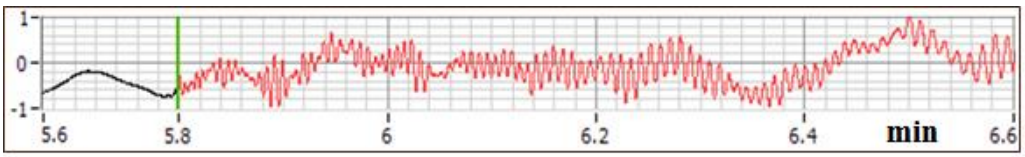

Fig. 1. Typical distant signals of “Bioscope” from the human palm. Green line corresponds to approaching the palm to the device’s sensor.

Acoustic impact was applied within 5 minutes with a sound of 750 Hz frequency. To provide 5-minute exercise the medical treadmill was used. The level of physical activity was corresponded to the run with the energy consumption of about 31 kcal. At the same time, the temperament of participants was evaluated by the testing method [6]. In the following analysis only dominant types of student's temperaments were considered. To analyze the obtained data the developed integrated program in LabView environment was used.

Table 1. Statistical indicators of "Bioscope"

NN	Abbreviations	Acronyms
PRIMARY INDICATORS		
1	<BB> (min)	Mean value of BB-intervals
2	Std_BB (min)	Dispersion of BB-intervals
3	CV (%)	Coefficient of variation of BB-intervals
4	RMSDD_BB (min)	Square root of the sum of squared differences of successive pairs of intervals of a series of BB-intervals
5	Max-Min (min)	Difference between the maximum and minimum values of BB-intervals
6	Max/Min	Ratio of the maximum and minimum values of BB-intervals
7	AMo (%)	Amplitude of histogram mode of BB-intervals
8	Mo (min)	Histogram mode of BB-intervals
9	F_BB=1/<BB>	The average frequency of signal oscillations
10	FFT	Spectral power density of "Bioscope" signals
11	FFT_BB	Spectral power density of BB-intervals
SECONDARY INDICATORS		
12	A=AMo/(Max-Min)	
13	B=1/(Mo*(Max-Min))	
14	C=AMo/(2*Mo*(Max-Min))	
15	D- Total number of BB-intervals assigned to AMo	
16	E=AMo/Mo	

The sequential interpeaks time intervals of signals (BB-intervals) were determined. By method of fast Fourier transform the spectral distributions for the initial signals, as well as time sequence of BB-intervals were made. Simultaneously, for totality of BB-intervals the values of 16 statistical indicators were calculated. Besides, the average oscillations frequency of recorded signals and the coefficient of variation of values of BB-intervals were calculated that reflect the character of recorded signals. Among these 16 indicators the 11 can be conditionally allocated as primary, using which the 5 additional (secondary) indicators were calculated (*Table 1*).
The mean values of these indicators were estimated for different groups of persons. The reliability of differences of calculated indicators in different experimental groups was evaluated using Students-test at a significance level of $p < 0.05$.

RESULTS AND DISCUSSION

The analysis has shown (see *Table 1*) that for male and female in norm there is a statistically significant difference between the values of all the indicators. In particular, for female the oscillation frequency of "Bioscope" signals is more than 1.5 times greater than the oscillation frequency for male.

Table 2. Mean values of some statistical indicators of integrative state of male and female in norm

	PRIMARY INDICATORS			
	F_BB	**CV (%)**	**FFT**	**FFT_BB**
Male	45.5±3.1	81.6±7.3	0.035±0.003	12E-5±5.4E-5
Female	74.4±8.8	54.7±4.6	0.062± 0.011	1.0E-5 ±0.3E-5
	SECONDARY INDICATORS			
	A	**B**	**C**	**E**
Male	81±9	1419±318	5144±1123	946±181
Female	296±61	3968±792	24570±7512	1744±437

Note: F_BB, CV%, FFT, FFT_BB, A, B, C, E are integrative indicators of "Bioscope" signals. For abbreviations see *Table 1*.

In norm, for persons of different gender there is a also significant difference in the spectral distribution of the "Bioscope" signals and spectrum of BB-intervals (*Fig. 2*). For female, in comparison with male, it is observed a multiple increase in the spectrum power of "Bioscope" signals at the low frequencies of 1-3 osc/min. At the same time,

for spectra of BB-intervals in the frequency range up to 10 osc/min the power of spectrum for male is much higher than the same for female.

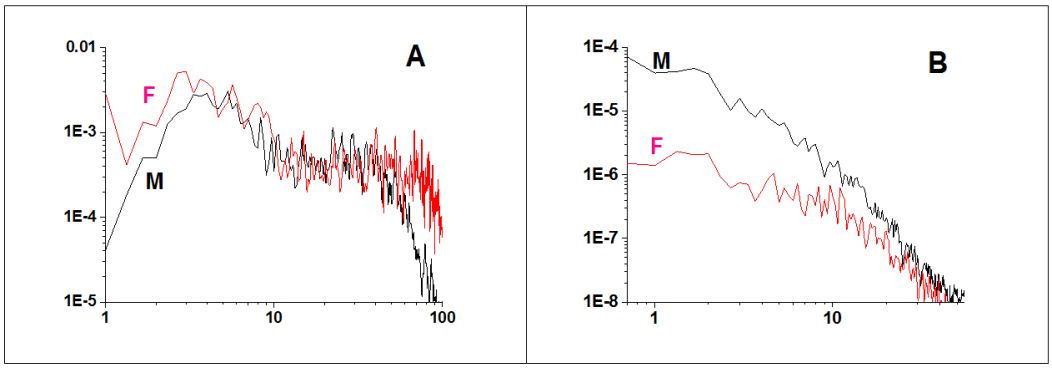

Fig. 2. The spectral distribution of the for "Bioscope» signals (A) and a spectrum of consecutive interpeaks intervals (B) of tested students in norm. On the x-axis – frequency (osc/min). M-male, F- female.

After the acoustic impact, as well as physical exercises, for male and female in the frequency range of more than 100 osc/min, the opposite direction in the change of spectral power of "Bioscope" signals is observed.
For female, the reliable changes in the values of integrative indicators are formed only after physical exercises.

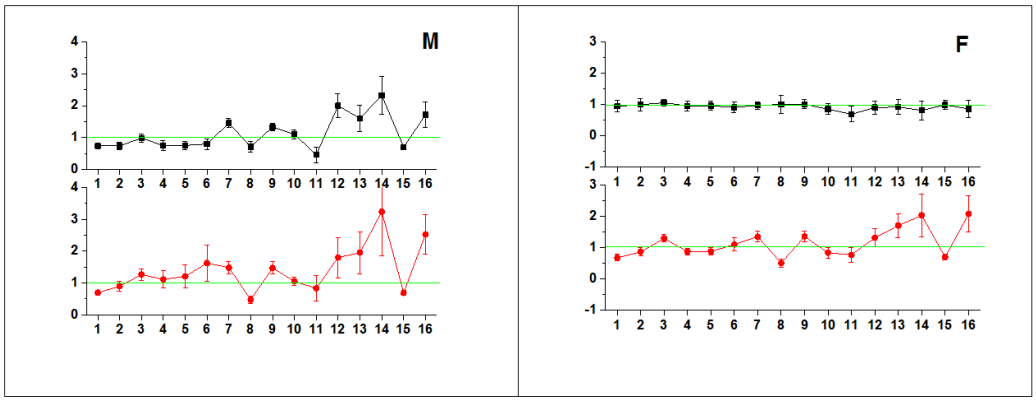

Fig. 3. Relative (to the norm) values of statistical indicators (A, B) and spectral distributions (C, D) of "Bioscope" signals after acoustic impact (black) and physical activity (red). The 1-16 are statistical signals of "Bioscope". For note see Table 1; M-male, F - female.

At this, after the acoustic treatment, as well as exercise in the frequency domain over 100 osc/min for males and females, the opposite direction of the change in the power spectra of signals of "Bioscope" is observed (*Fig. 4 M,F*).

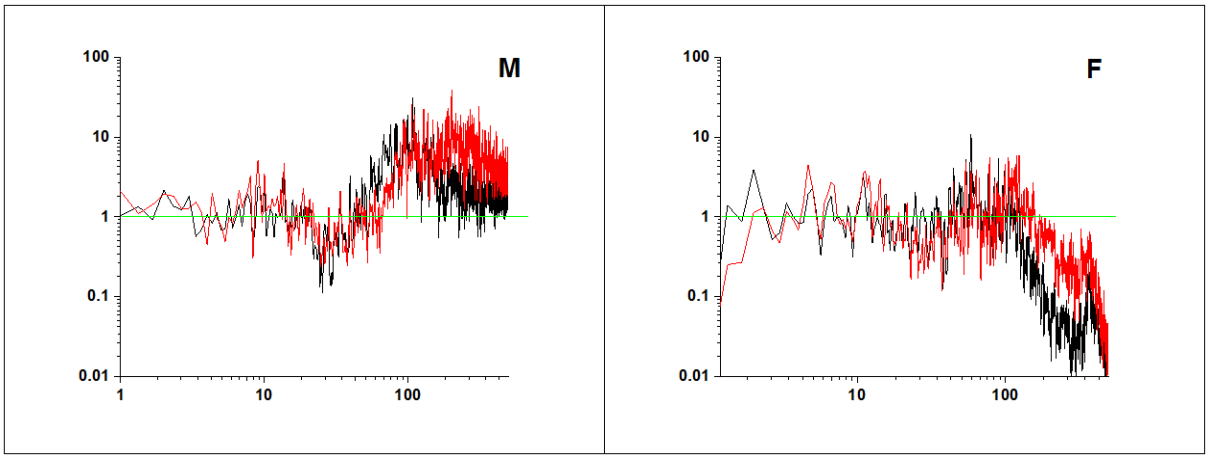

Fig. 4. Relative (to the norm) spectral distribution of "Bioscope" signals after the acoustic impact (black) and physical activity (red). On the X-axis is the frequency osc/min.

According to the *Fig. 5M*, for male it is observed a multiple decrease in the spectrum power of consecutive interpeak intervals in the frequency range of 1-3 osc/min after the acoustic effects and exercises. For female the opposite picture is formed. The most pronounced increase in spectral power occurs after physical exercises.

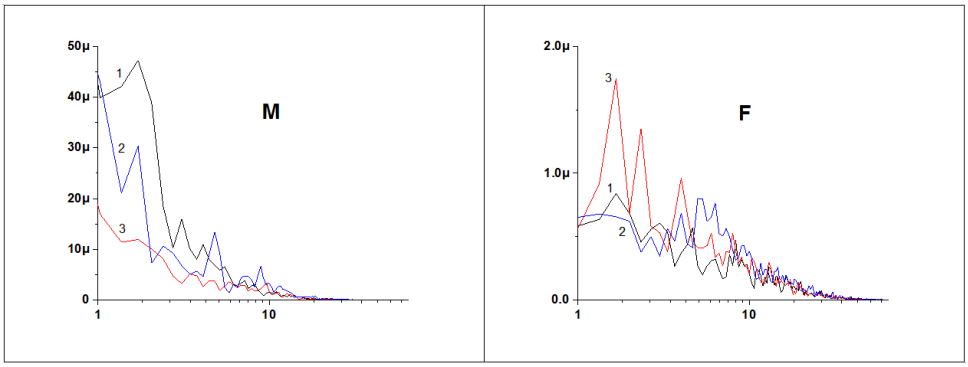

Fig. 5. Effect of acoustic impact and physical exercise on the spectrum of the interpeaks intervals of "Bioscope" signals. Black - control; blue - after acoustic effects; red - after exercise.

For evaluation of possible role of human temperament in the nature of "Bioscope" signals in norm and after physical impact all participants were divided into 4 known groups by their characteristic temperaments. In the investigated group of male dominate the choleric, sanguine and phlegmatic temperament types (*Fig. 6A-M*) while in the group of female, the sanguine and phlegmatic temperament types (*Fig. 5A-W*). The melancholic type of temperament in the studied groups of both genders was absent.

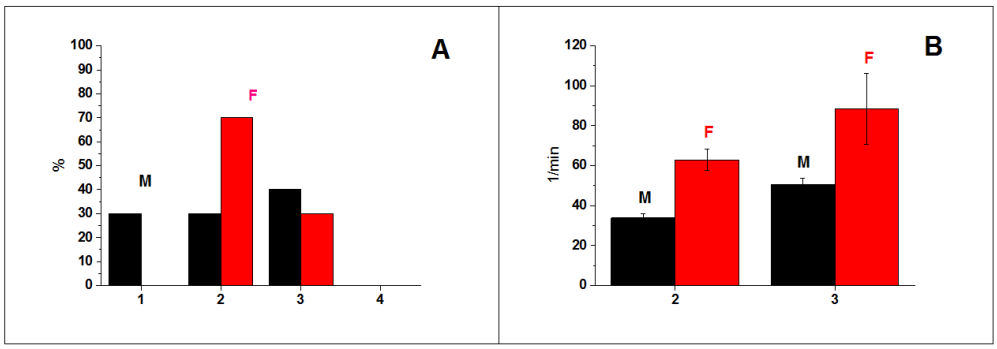

Fig.6. Representation of the dominant types of temperaments (A) and the average frequency of "Bioscope» signals (B) for male (M) and female (F) in norm. 1 - choleric; 2 – sanguine; 3 – phlegmatic; 4 - melancholy;

The analysis has shown that regardless of gender of tested participants the frequency of "Bioscope" signals for the phlegmatics in norm is higher than for the sanguine. At the same for both types of temperaments the frequency of "Bioscope" signals for female is higher than for male.

Quite unexpectedly is pronounced difference in the spectral distribution of interpeaks intervals of "Bioscope" signals for persons belonging to different dominant types of temperament (*Fig. 7*).

In both men and women in the frequency range up to 10 osc/min it is observed a marked differences in the spectral distribution of the interpeaks intervals of "Bioscope" signals for persons belonging to different types of dominant temperament.

Moreover, the analysis showed that for sanguine male the trend of changes in values of integrative indicators after acoustic impact and physical exercises is opposite, whereas for phlegmatic male the direction of changes is the same (Fig. 8A, BM). At the same time for , men and women, sanguine male and female after exercises, the opposite direction in the change of integrative indicators (*Fig. 8 A-M, W*). We also add that regardless of the type of dominant temperament of female (sanguine or phlegmatic in this case) after the acoustic impact the values of statistical indicators do not change, whereas physical activity leads to unidirectional changes in their values (*Fig. 8 A, B-W*).

Thus, the study has revealed a significant difference in the values of the indicators of regulatory of "Bioscope" signals for male and female students in the age group of 20-22 years. It is shown the difference in reactions of the organism of male and female to an external acoustic stimulation and physical exercise. In practical terms, it is extremely important that all this can be identified in just a 3-minute registration at a distance of 1 cm of the palm of a person from sensor of devices. Very interesting is also a significant difference in the spectral distributions of successive interpeaks intervals of signals of "Bioscope" depending on the dominant type of temperament of humans. The obtained results indicate the

need in all psychophysiological studies to consider the factor of gender, as well as the difference in their psychological status.

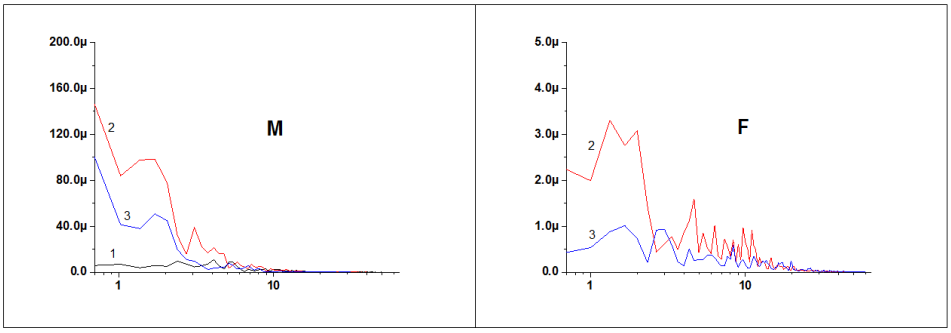

Fig. 7. Spectra of successive interpeaks intervals of "Bioscope" signals. The predominant type of temperament: black - choleric; red - sanguine; blue - melancholic;

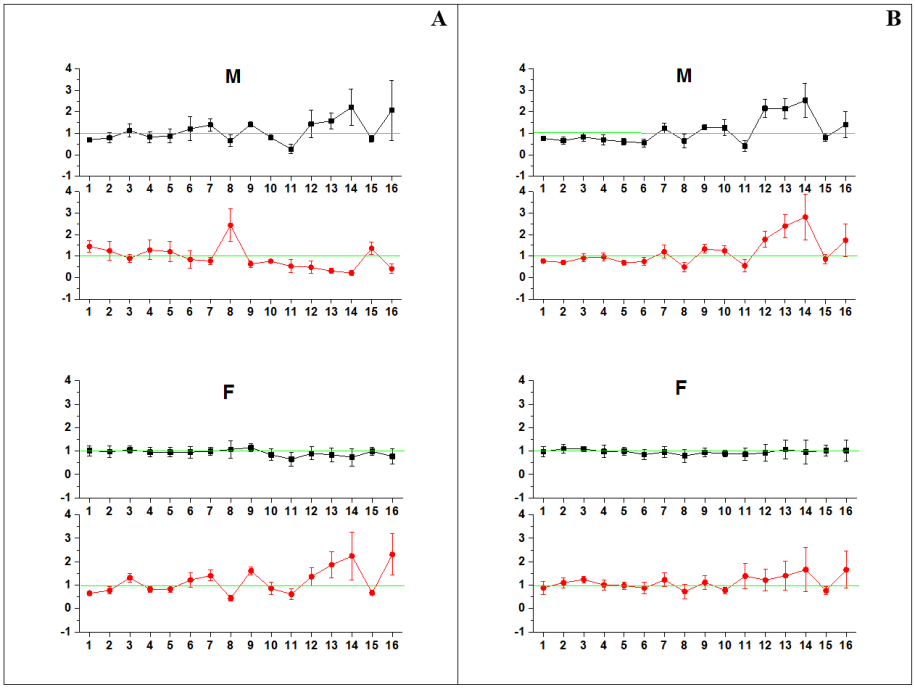

Fig.8. Relative (to the norm) values of integrative indicators of the subjects after acoustic effects (black) and physical activity (red) depending on the dominant sanguine (A), and phlegmatic (B) types of temperaments. M-male, F-female; 1-16 – statistical indicators of "Bioscope" signals.

CONCLUSIONS

The study has revealed a significant difference in the values of integrative indicators of the physiological state of persons. The most informative in assessing the functional state of the human can be particularities of spectral distribution of interpeaks intervals of "Bioscope"
signals.
In essence, the possibility of using the hardware complex "Bioscope" to assess the functional state of the human organism in norm and in conditions of external influences of different physical nature. It is shown that the signals of "Bioscope" differ for persons of different gender.
Very interesting is the sensitivity of "Bioscope" signals to dominant type of temperament of human.
One might think that the developed device in the following may be useful for identifying the beginning of the various pathological processes in the body.

REFERENCES

[1] Draayer J.P., Grigoryan H.R., Sargsyan R.Sh., Ter-Grigoryan S.A., **2007.** Systems and Methods For Investigation of Living Systems / US Patent Application 0149866 A1.
[2] Sargsyan R.Sh., Karamyan G.G., Avagyan M.N., **2010.** Noninvasive Assessment of Physiologic State of Living Systems / The Journal of Alternative and Complementary Medicine, v. 16, N 11, 1–8.

[3] Sargsyan R.Sh., Gevorkyan A.S., Karamyan G.G., Vardanyan V.T., Manukyan A.M., Nikogosyan A.H., **2010.** Bioscope: new sensor for remote evaluation of the physiological state of biological system / Proceedings of NATO ARW "Physical properties of nanosystems", Springer, 303-314.
[4] Sargsyan R.Sh., Karamyan G.G., Gevorkyan A.S., **2010**. Quantum-Mechanical Channel of Interactions between Macroscopic Systems, / AIP (American Institute of Physics) Conference Proceedings, 1232, 267-275.
[5] [5] Sargsyan R.Sh., Karamyan G.G., **2014**. Nonlocal correlations in macroscopic systems / NeuroQuantology, v. 12, N 4, 355-365.
[6] http://www.psyportal.info/tests/test_na_opredelenie_temperamenta?test=1